



Coffee Break Training - Fire Protection Series

Fire Dynamics: Spontaneous Heating of Agricultural Products

No. FP-2013-25 June 18, 2013

Learning Objective: The student shall be able to describe the process of spontaneous heating in agricultural products.

In many parts of the Northern Hemisphere, farmers now are reaping their first cutting of hay to be formed into bales and stored for later use. Spontaneous heating to ignition of improperly dried hay in storage is a leading cause of agricultural fires each year. Many agricultural products are susceptible to spontaneous heating, including corn meal feed, linseed, rice, bran and pecan meal.

Spontaneous heating in agricultural products is the result of plant and microbial respiration, where the microbes consuming sugars in the presence of oxygen results in the production of carbon dioxide, water vapor and heat. With hay, heat produced in the center of the stored mass — such as when the hay is tightly baled — cannot easily escape and may increase to the point where the hay is ignited. Ignition generally occurs at about 175 F (80 C) and can occur within days of the hay being baled.

Three factors influence the likelihood that the hay, in particular, or other agricultural products will self-heat to ignition: 1) rate of heat generation, 2) air supply, and 3) insulation properties of the immediate surroundings.

The heating rate at normal ambient temperatures is usually so slow that the released heat escapes to the atmosphere as rapidly as it is formed, with no increase in temperature of the product. This is not true of all combustible materials, since certain reactions generate heat more rapidly than it can be dissipated, with a resulting temperature increase in the material.

In order for spontaneous ignition to occur, there must be sufficient oxygen available for the reaction to proceed but not so much air flow that the heat is carried away as quickly as it is generated. For example, a hay bale may heat spontaneously in the center of a stored pile but would not do so if on the outside of a pile where air movement would remove the heat as quickly as it was formed. Because of the many possible combinations of air supply and insulation, it is impossible to predict with certainty whether or not a material will heat spontaneously.

If the spontaneous heating in hay bales is detected early enough, the hay can be removed from the arrangement prior to ignition. In many cases, the heating is not detected until fire breaks out. The following table provides the range of temperatures that may lead to ignition. The person responsible for the product storage can insert a thermal probe to monitor for these temperatures.

F	C	Condition
150	65	The stored hay is entering a dangerous zone and its temperature should be checked daily.
160	71	As the temperature rises to this range, it should be monitored every four hours and the entire storage arrangement should be checked.
175	80	Steps should be taken to prepare for fire suppression, including calling the fire department. The hay should be wetted and removed from the storage arrangement.
185	85	Hot spots and pockets may be expected, and flames likely will occur when heating hay is exposed to the atmosphere.
212	100	At this point, the temperature is critical and will rise rapidly. Hay will almost certainly ignite.



The hay stored in this barn has been dried in the fields to minimize the likelihood of spontaneous heating.



Eligible for Continuing Education Units (CEUs)
at www.usfa.fema.gov/nfaonline

For archived downloads, go to:
www.usfa.fema.gov/nfa/coffee-break/